LEVELL

INSTRUCTION BOOK

MP MASTER
MA23354

10s/CA2504.

OPERATING INSTRUCTIONS

for

D.C. MULTIMETERS

TYPE TM9 SERIES

GUARANTEE.

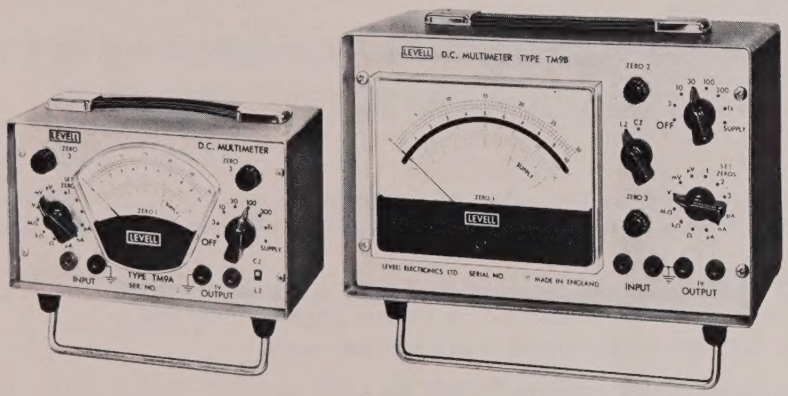
We undertake to repair, or replace free of charge, any components that fail within 12 months of the date of purchase of an instrument provided that the instrument is not, in our opinion, modified or misused. Instruments returned by post should be well packed to avoid damage. We recommend the use of two strong cartons, one to fit closely around the instrument and the other large enough to float the small carton in at least 2" thickness of wood wool.

LEVELL ELECTRONICS LIMITED, PARK ROAD, HIGH BARNET, HERTS., ENGLAND.

Telephone: 01-449-5028.

D.C. MICROVOLTMETER + PICOAMMETER + NULL DETECTOR + AMPLIFIER + OHMMETER

- 18 VOLTAGE RANGES from 3μV to 1kV f.s.d. with HIGH INPUT IMPEDANCE.
- 18 CURRENT RANGES from 3pA to 1mA f.s.d. + 6 ranges up to 1A on TM9BP.
- 18 RESISTANCE RANGES from 3 Ω to 1kM Ω with LINEAR SCALES.



TYPE TM9A: Meter scale length 3¼″ (8.3cm.) TYPE TM9B: Meter scale length 5″ (12.7cm). Mirror scale.

TYPE TM9BP: As type TM9B plus 6 extra current ranges from 3mA to 1A f.s.d.

The D.C. ranges provided on these portable instruments cover the measurement of voltage from 0.3μV to 1kV, current from 1pA to 1mA (or 1A) and resistance from 0.3 Ω to 1000M Ω. All ranges are linear with a recorder output provided. Selectable left zero or centre zero scales ensure optimum performance in both measurement and null detector applications.

Features include high input impedance and high A.C. rejection on the 18 voltage ranges, low voltage drop on the 18 (or 24) current ranges, low test voltage on the 18 linear resistance ranges and large overload rating on all ranges.

The instrument contains a high gain chopper stabilised D.C. amplifier with entirely solid state circuitry. All the components are operated at levels well below their maximum ratings and the input is protected against overloads. There are no vibrating contacts or flickering neon tubes to cause long term drifts. The power consumption is very low resulting in negligible warm-up drift and a life of 1000 hours from a self-contained battery. The performance is stabilised against variations in the battery voltage so that the instrument may be operated for many days with a low drift that is determined solely by variations in ambient temperature.

The D.C. amplifier has 100% series negative feedback applied on the 1V range so that the gain is unity. High stability metal film resistors are used to attenuate the negative feedback to give the ranges of 300mV, 100mV, 30mV . . . 3μV. The amplifier output is connected to the output sockets and to the meter which has a sensitivity of 1V at full scale deflection. A digital voltmeter or a pen recorder may thus be connected across the output sockets with the D.C. amplifier used to increase the sensitivity up to 333,300 times.

The instruments are finished in robust steel cases that are fitted with carrying handles. The cases stand on insulated feet and insulated hinged legs are provided for tilting the cases up by about 20°. Optional extras are LEVELL A.C. Power Supply Units and Cases.

SPECIFICATION OF TYPE TM9 SERIES

VOLTAGE RANGES

3μV, 10μV, 30μV . . . 1kV. Accuracy ± 1% ± 1% f.s.d. ± 0.1μV.

Noise <0.5μV p-p on the 3μV range for source resistance up to 30k Ω.

Drift <0.7μV/°C and <0.7μV/day after warm-up of 2 mins.

Input resistance >1M Ω/μV up to 10mV, >10kM Ω from 30mV to 1V, 100M Ω above 1V. Rise time on 3μV, 10μV, 30μV, 100μV to 1kV is 10s, 3s, 1s, <1s.

CURRENT RANGES

3pA, 10pA, 30pA . . . 1mA (1A for type TM9BP). Accuracy ±2% ± 1% f.s.d. ± 0.3pA. Noise <0.7pA p-p on the 3pA range. Drift <1pA/°C and <1pA/day after warm-up of 2 mins. Input resistance 1M Ω up to 1nA, 100k Ω from 3nA to 1μA, 100 Ω from 3μA to 1mA, 0.12 Ω from 3mA to 1A for type TM9BP. Rise time on 3pA, 10pA, 30pA, 100pA to 1A is 15s, 5s, 1.5s, <1s.

RESISTANCE RANGES

3 Ω, 10 Ω, 30 Ω . . . 1kM Ω. Accuracy ±1% ±1%f.s.d. up to 100M Ω rising to ±10% at 1kM Ω.

Test voltage is 3mV at f.s.d. on Ω ranges.

Test currents are 1μA and 1nA on k Ω and M Ω ranges.

A.C. REJECTION

Superimposed A.C. at 50 to 60Hz affects the reading by less than 1% f.s.d. for peak to peak input voltages up to 50 times f.s.d. on ranges up to 10mV, and up to 10 times f.s.d. for ranges above 10mV.

RECORDER OUTPUT

0 to +1V at f.s.d. into not less than 1k Ω on left zero ranges.

—0.5V to +0.5V into not less than 5k Ω on centre zero ranges.

MAXIMUM OVERLOADS

2kV peak on V ranges. 350V peak on mV, μV, and pA ranges.

2mA peak on nA ranges. 50mA peak on μA ranges. 2A peak on mA ranges.

TEMPERATURE

The characteristics specified above are measured at 25°C but only minor divergencies exist from —5°C to +45°C.

CONNECTIONS

The input and output sockets accept 4mm. banana plugs at $\frac{3}{4}$″ spacing.

The input test leads are 18″ (i.e. 45cm) long and terminated by brass crocodile clips.

POWER SUPPLY

One type PP9 battery, life 1000 hours; or, A.C. mains when a LEVELL Power Unit is fitted.

SIZES, WEIGHTS & VARIATIONS

TM9A: 5″ × $7\frac{1}{4}$″ × $4\frac{1}{2}$″ (i.e. 13cm × 18.5cm × 11.5cm) $4\frac{1}{2}$lbs. (i.e. 2kg) Meter scale length $3\frac{1}{4}$″ (i.e. 8.3cm).

TM9B: 7″ × $10\frac{1}{4}$″ × $5\frac{1}{2}$″ (i.e. 18cm × 26cm × 14cm) 8lbs. (i.e. 3.6kg) Meter scale length 5″ (i.e. 12.7cm) fitted with mirror.

TM9BP: As TM9B plus current ranges up to 1A.

LEATHER CASES

Cases are available as optional extras. They are stiffened with board and felt lined. Shoulder straps are detachable and it is possible to use an instrument whilst in a case.

OPERATING INSTRUCTIONS FOR LEVELL D.C. MULTIMETERS TYPE TM9 SERIES

1. Connection of the Power Supply

Remove the back of the instrument and connect the 9V battery (Ever Ready type PP9 or equivalent) by means of the snap fastener connection provided.

A Levell Power Supply Unit type PU8S may be fitted in place of the battery when operation is required from an A.C. mains supply. The Earth Connection on the Power Unit must be joined to the case of the instrument.

Replace the back of the instrument taking care to ensure that the back screws are tight so there is good electrical contact between the back cover and the instrument case.

Set the Multiplier switch to the "Read Supply" position. Check that the pointer is between the supply limits marked on the scale.

2. Zero Controls

The three zero controls should be set as follows:

(a) Set the Multiplier switch to any position other than "OFF" or "READ SUPPLY".

(b) Select "CZ" on the Left Zero/Centre Zero switch.

(c) Select "Set Zero 1" on the Function switch.

(d) Adjust the "Zero 1" button on the meter until the pointer is at 0 on the red scales.

(e) Select "Set Zero 2" on the Function switch.

(f) Adjust the "Zero 2" control slowly until the pointer is on average at 0 on the red scales. A small fluctuation will exist due to thermal noise voltages.

(g) Select "Set Zero 3" on the Function switch.

(h) Adjust the "Zero 3" control slowly until the pointer is on average at 0 on the red scales.

(i) Set the LZ/CZ switch to the position required for subsequent measurements.

(j) Select "Set Zero 1" and, if needed, reset Zero 1 for 0 on the chosen scales.

The Zero 1 adjustment is the mechanical control button which sets the balance of the meter movement so that the pointer is at 0 on the black left zero scales when no current is fed into the meter coil. The Zero 1 control could thus be set when the instrument is "OFF" but the position "Set Zero 1" on the Function switch enables the zero to be set when the instrument supply is on so that the adjustment can be made at 0 on the red centre zero scales. A stabilised current is used to provide forward bias on the meter when CZ is selected. This current is controlled by the preset potentiometer marked "CZ" that is located on the rear printed circuit board which is visible when the rear coverplate is removed. Long term drifts on components could cause a small error to appear such that when the meter is set to zero on the black scales in the "LZ" position subsequent selection of "CZ" does not move the meter to 0 on the red scales. Adjustment of the "CZ" preset control is then required but should only be done after checking that the supply is within the limits marked on the meter and that the "Ω" control is at its correct settings.

The Zero 2 and Zero 3 adjustments are potentiometer controls which correct for the offset voltage and current errors respectively of the chopper stabilised D.C. Amplifier. The coverages of these controls is limited to be only sufficient to overcome errors caused by temperature variations. Long term ageing of components could cause the condition to arise where one of the controls cannot be set to give zero at one extreme of the temperature range. Adjustment of the preset controls marked "Z2" and "Z3" is then necessary. These controls are located on the rear printed circuit board. The adjustments should only be made after the instrument has been located for at least one hour at a temperature that is approximately the mean of the temperature range in which the instrument is subsequently required to operate. (This is generally 20°C for use in the U.K.) The panel zero controls Zero 2 and Zero 3 should be set to the mid points of their swings. Preset controls Z3 and Z2 should then be set to give zero when Set Zero 3 and Set Zero 2 are selected. The adjustments must be made in the order Z3 and then Z2. The rear metal cover plate must be held in place after an adjustment is made as the presence of this plate affects the zero point and the adjustments must be repeated until both zeros are achieved with the plate in position.

It may be found that, after the zeros are set as described above, a reading is obtained on the 3μV range when the input connections are apparently shorted by external leads. The cause of such a reading is then generally due to thermo electric voltages that are produced by small temperature differences on dissimilar metals on the connecting leads, plugs and crocodile clips. The input plugs and crocodile clips that are provided are made of brass but copper wire is used for the connecting leads. Brass/copper junctions generate thermo electric voltages at a rate of 2.4μV/°C so it follows that a difference of 0.1°C provides a significant output. It is possible to avoid trouble from the junctions at the input plugs by keeping both plugs at the same temperature. This can be done

by ensuring that both plugs are fully inserted so no metal parts are exposed, that neither is handled prior to a measurement and the leads from each input plug are tightly twisted together as close as possible to the plugs. The instrument is best located in a position free from temperature gradients and draughts. A bad location is on top, or directly adjacent to, a hot mains driven instrument such as an oscilloscope. The use of expanded polystyrene tiles is recommended to provide heat shields around the instrument when μV measurements are required to be made in conditions with severe temperature gradients.

3. Voltage Ranges

The D.C. Amplifier operates on the 1V range with 100% series negative feedback applied so that the gain is unity. The amplifier output is connected directly to the "OUTPUT" sockets and the meter is connected directly across these sockets. The meter sensitivity is controlled by the preset potentiometer marked "1V OUT" that is located on the rear printed circuit board. This control is set so that the meter reads correct when a standard input of 800mV ± 0.2% is fed into the voltmeter on the 1V range. Adjustment will not normally be required unless the meter is changed as high stability components are used in the circuit.

The Multiplier switch varies the portion of the output voltage that is applied as series negative feedback such that the "mV" ranges of 3, 10, 30 ..... 1k correspond to 0.3%, 1%, 3% ..... 100% of the output applied as feedback. High stability metal film resistors are used on the attenuator chain and a fine adjustment is provided on the "3" position by means of the miniature open type preset potentiometer that is located on the lower right hand corner of the rear printed circuit board. Adjustment of this control is made on the 3mV range with a standard input of 2.4mV ± 0.2%.

The "μV" Ranges are derived by switching a 1000:1 attenuator in series with the negative feedback circuit. This attenuator is controlled by the preset potentiometer marked "1mV" that is located on the rear printed circuit board. This preset control is set with a standard input of 800μV ± 0.2% fed into the Voltmeter on the 1mV range.

The "V" ranges are derived by using the mV ranges with an extra attenuator of 1000:1 switched in circuit in front of the D.C. Amplifier. This attenuator is controlled by the preset potentiometer marked "10V" that is located on the rear printed circuit board. This potentiometer is adjusted on the 10V range so that an external input of 8V gives the same reading as is produced on the 10mV range when the external input is divided down by 1000 times using an external standard attenuator that is accurate to within ± 0.2%.

4. Current Ranges

The "pA" ranges use the D.C. Voltmeter at sensitivities from 3μV up to 1mV f.s.d. with an input resistor of 1MΩ shunted across the input circuit. This resistor is a high stability close tolerance component and no preset adjustment is provided.

The "nA" and "μA" ranges are produced by operating the D.C. Voltmeter at a sensitivity from 300μV up to 100mV dependent upon the setting of the Multiplier switch. The input shunt resistor is 100kΩ and 100Ω respectively on the nA and μA ranges. The miniature open type preset potentiometer that is located on the upper right hand corner of the rear printed circuit board controls the accuracy of both the nA and μA ranges. This control is normally set with an external standard current input of 8μA ± 0.2% applied on the 10μA range.

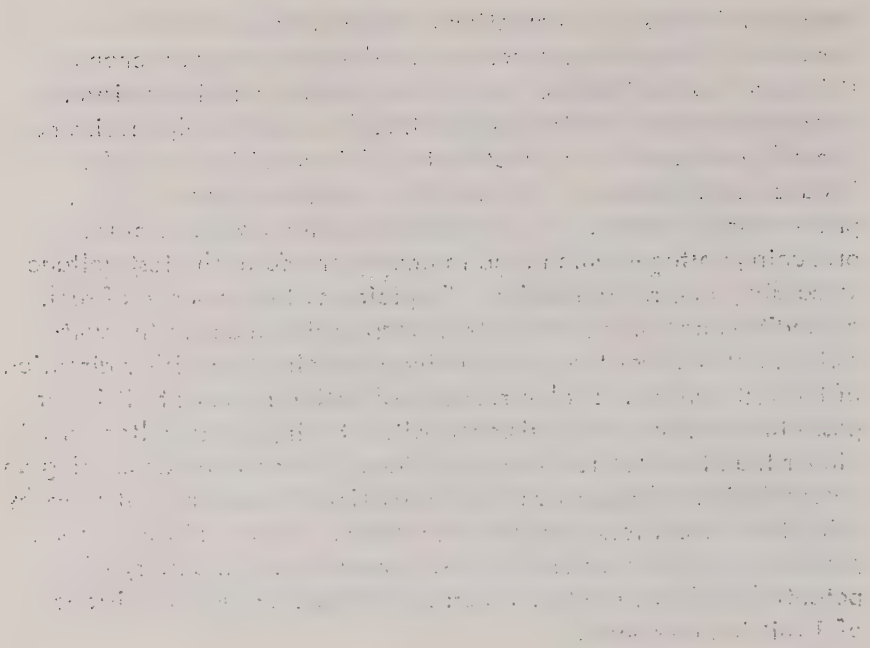
5. Resistance Ranges

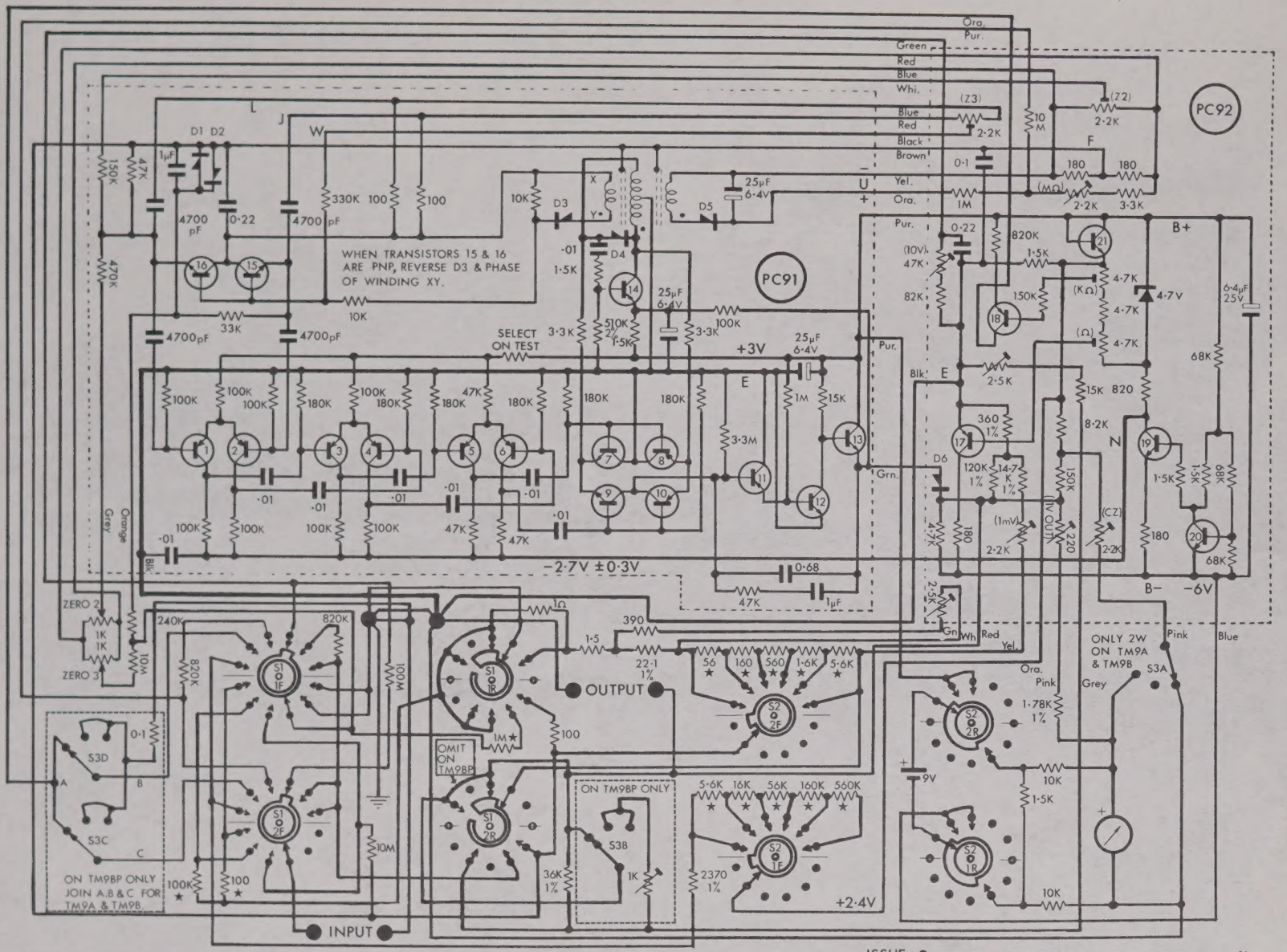
The "Ω" ranges are produced by operating the D.C. voltmeter at a fixed sensitivity of approximately 3mV f.s.d. and applying a constant current to the input circuit that is set at 1mA, 300μA, 100μA ..... 3μA as the Multiplier switch is rotated 3, 10, 30 ..... 1k. The preset potentiometer marked "Ω", that is located on the rear printed circuit board controls the accuracy on all the Ω ranges. It is normally set so that a correct reading is obtained on the 1kΩ range when an external standard resistor of 800Ω ± 0.2% is connected across the input terminals. On the 3Ω range a small reading of the order of 0.05Ω will exist when the test leads are shorted. This is due to the resistance of the leads and must be allowed for when measuring low resistances by subtraction from the measured resistance value.

The "kΩ" ranges use the D.C. Voltmeter ranges from 3mV up to 1V with a constant current of 1μA fed into the input connections on all ranges. The magnitude of this current is controlled by the preset potentiometer marked "kΩ" that is located on the rear printed circuit board. This preset control is normally adjusted for correct reading on the 1MΩ range when an external standard resistor of 800kΩ ± 0.2% is connected across the input terminals.

The "MΩ" ranges use the D.C. Voltmeter ranges from 3mV up to 1V with a constant current supply of 1nA applied to the input circuit. The magnitude of this current is controlled by the preset potentiometer marked MΩ that is located on the rear printed circuit board. This control is normally adjusted for correct reading on the 10MΩ range when an external standard resistor of 8MΩ ± 0.2% is connected across the input terminals. Care must be taken on the MΩ ranges to avoid rapid movement of the input

leads as this causes a fluctuation on the reading due to the variation of the voltage across the leads as the capacity changes. It is worth noting that the use of a low voltage for high resistance measurement does sometimes cause trouble when the high resistance is partly composed of an electrolyte. This condition exists for instance when measuring the insulation resistance across a damp printed circuit board. Electrochemical action may take place producing voltages which tend to oppose or add to the test voltage so causing an error in reading. Suspicion of the presence of such a condition can be confirmed by reversing the leads to the voltmeter to check that the same reading is obtained for either direction of the test current. If electrochemical action is present, it is not possible to measure the resistance without using a test voltage much higher than the electrochemical voltage. This can be done using an external high voltage source and measuring the current that flows by using the current ranges of the instrument. The use of this method permits very high resistances to be measured e.g. a battery of potential 10V will produce a current of 10pA through a resistance of 1 Million Megohms.





LEVELL D.C. MULTIMETERS TYPE TM9 SERIES

ISSUE : 2

RESISTORS MARKED ★ ARE 0·5%; UNMARKED ARE 5% 4·7–1M & 10% BELOW 4·7 & ABOVE 1M.

HEWLETT

D.C. MULTIMETERS TYPE 1MR SERIES

MP MASTER
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